

THE NATIVE FLORA OF CHURCHILL, MANITOBA

*with notes on the history, geology
and climate of the area.*



BY
H. J. SCOGGAN

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GUIDE BOOK

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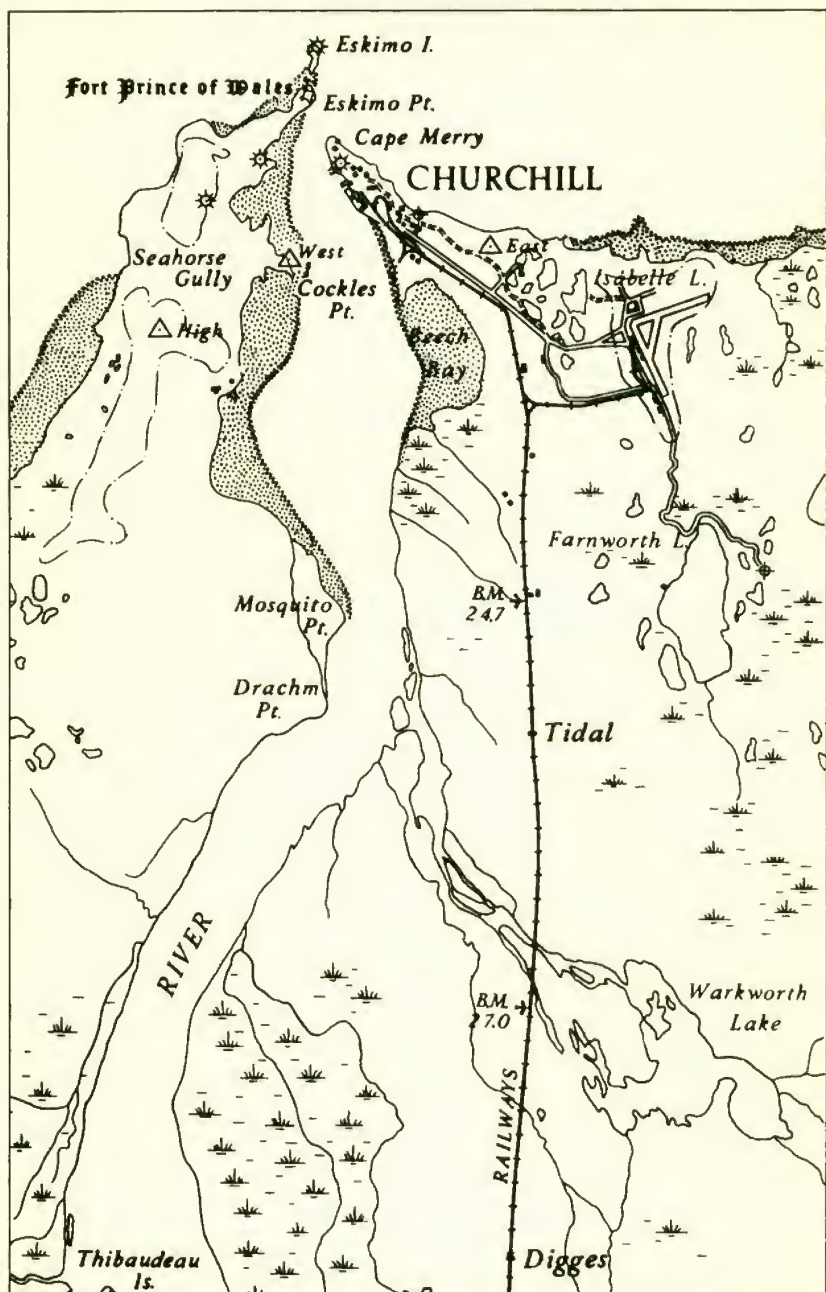
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Map of Churchill area.

THE NATIVE FLORA OF CHURCHILL, MANITOBA

HISTORICAL NOTES ON CHURCHILL AND

THE HUDSON BAY REGION

(See Alcock, 1916; 1920; Department of Railways, Labour and Industries, Regina, Saskatchewan, 1933; Department of Transport, Canada, 1939; Harrington, 1951; Innis, 1930; Morton, undated; Pinkerton, 1932; Trémaudan, 1915; Williams, 1949.)

1610 – Henry Hudson, in search of a North-West Passage to the Orient, discovered the strait and bay that bear his name. After wintering near the mouth of Rupert River at the southeast end of James Bay with his sick and demoralized crew, he was cast adrift in an open boat, never to be heard of again.

1612 – Thomas Button, continuing the quest, and hoping to find traces of Hudson, wintered at the mouth of Nelson River, taking possession of the land for England.

1619 – Jens Munck, son of a Danish nobleman, discovered the mouth of Churchill River and wintered there rather than attempt the hazardous return voyage during the stormy autumn season. Scurvy and exposure killed all but Munck and two others, who managed to bore holes in the larger vessel, the *Unicorn*, to sink her, and returned to Denmark in the *Lamprey*. Indians, coming across the profusion of dead, strangely garbed bodies a few months after Munck had left, named the river the River-of-the-Strangers.

1631 – By this date, three years before the death of Samuel de Champlain, seventeen expeditions (sixteen English and one Danish) had approached the northern forest belt by sea, while in the south the French had come within easy reach of it from the St. Lawrence River.

1650 – Defeat of the Huron Indians by the Five Nations, shattering the machinery of the French fur trade.

1661 – Médard Chouart des Groseilliers and Pierre Esprit de Radisson penetrated the beaver country of the northern forest belt, tapping the stream of furs at its source. The subsequent rejection by the French Court of Groseilliers' plans for new ventures to Hudson Bay gave the English an entry to the great fur belt, and proved decisive for the history of the Canadian Northwest.

1668 – Groseilliers (the “Mr. Gooseberry” of old Hudson’s Bay Company documents), with an English expedition under the command of Captain Zachary Gillam, reached Rupert River, James Bay. The building there of Fort Charles effected the first direct and vital contact of the Northwest with Europe.

1670 – King Charles II of England granted a charter to the “Governor and Company of Adventurers of England trading into Hudson’s Bay” and their successors, constituting them “the true and absolute lords and proprietors” of that vast, practically unknown territory draining into Hudson Bay, with the sole trade and commerce rights in a region more than half as large as Europe. The title was later changed to the “Hudson’s Bay Company” after amalgamation with The Northwest Company. In rapid succession, trading posts were established at the mouths of the Albany, Moose, Rupert, Nelson, Severn, and Churchill rivers, the whole territory receiving the name Rupert’s Land, after the chief promoter and first governor, Prince Rupert.

1684 – Establishment of York Factory near the mouth of Hayes River, following the destruction of Fort Nelson by the French the preceding year. This post was the oldest permanent settlement in Manitoba until its abandonment in 1957. It long served as the main supply centre of the company, goods from England for the interior being routed through it, and furs being collected there for the return voyages.

1686 – John Abraham explored Churchill River, naming it after Lord Churchill, later first Duke of Marlborough, the newly appointed governor of the Company.

1689 – A party including the explorer, Henry Kelsy, built the first Fort Churchill on the west bank of the river estuary. It was destroyed by fire the same year.

1690 – Henry Kelsy travelled from York Factory up the Hayes, Nelson, and Minago rivers, reaching Saskatchewan River near the present The Pas the following year. He was the first European to see the Indians and buffalo of the plains.

1717 – James Knight, the first Governor-in-Chief on the Bay, rebuilt the timber Fort Churchill on its original location. It was later named “Prince Wales fort” in honour of George, Prince of Wales, later George II.

1731 – The threat of French domination of the Bay induced the Hudson's Bay Company to commission the Governor of Churchill to build a new stone Fort Prince of Wales on Eskimo Point at the river mouth commanding the harbour entrance, which is only about a quartèr of a mile wide at this point. A battery of guns on Cape Merry, on the opposite shore, was set up to face the fort. The fort, designed by British military engineers, was completed in 1771, during the governorship of Samuel Hearne. Its dimensions were 310 feet east and west by 317 feet north and south. Masonry walls were nearly 17 feet high, and angular bastions guarded each corner. The ramparts, originally 25 feet thick, were later brought up to 42 feet in thickness.

1743–51 – Publication of the earliest important work referring to the natural history of the Hudson Bay region, *A Natural History of Uncommon Birds and of some other Rare and Undescribed Animals*, by George Edwards.

1770 – Samuel Hearne set out from Fort Prince of Wales on the famous overland journey during which he discovered Coppermine River and Great Slave Lake. In 1768, "Northern Indians" (Chipewyans) had brought pieces of copper to the Churchill post and said they got it on the banks of a "Far Away Metal River" to the northwest flowing into a northern ocean. After almost unbelievable hardship and misfortune, Hearne reached the mouth of the Coppermine in 1771 and returned to Churchill the following year after an absence of almost eighteen months. Unaware that England and France were at war, Hearne, in 1782, with a garrison of but thirty-nine men, was obliged to surrender Fort Prince of Wales to Admiral de la Pérouse and a force of four hundred French soldiers. When peace was signed the following year, Hearne was reinstated as governor at Churchill.

1774 – Establishment of Cumberland House in present-day Saskatchewan by Hearne, marking the beginning of the policy of penetration into the interior by the Hudson's Bay Company in answer to the opposition of rival fur traders.

1794 – David Thompson surveyed a new route between Cumberland House and York Factory via Goose, Reed, and Burntwood lakes to the Nelson.

1811 – Conveyance to Lord Selkirk, for the settlement of a group of Irish colonists, of an area of about 116,000 square miles in present-day Manitoba, Saskatchewan, North Dakota, and Minnesota. Miles Macdonell was chosen Governor of Assiniboia. He then set out with an advance party to prepare for the arrival of the settlers the following year. Forced to winter at the mouth of the Nelson, the group travelled up the Hayes the following spring, then down Lake Winnipeg and up the Red River to establish the Red River Colony near what is now Winnipeg, the beginning of the present vast agricultural settlements of the western prairies.

1819–22 – Sir John Franklin's first overland expedition from York Factory to the mouth of Coppermine River via the Hayes and Saskatchewan rivers and Great Slave Lake. He was accompanied by John Richardson, navy surgeon and naturalist, whose plant collections are listed in an appendix to Franklin's *Narrative*, published in 1823, and are also treated in Sir William Hooker's *Flora Boreali-Americana*.

1821 – Union of the rival Hudson's Bay and North-West Companies. The disappearance of the old-time competition between the two companies for the trade of the interior meant that the Indians could now be depended upon to travel much longer distances to the main trading posts than formerly, and the lower part of the Churchill River, with its treacherous currents, was completely abandoned as a trading route.

1846 – Dr. John Rae, who later discovered relics of Franklin's ill-fated third expedition, sailed from Churchill to Repulse Bay. A list of plants collected by Rae between York Factory and Churchill is given in his narrative of 1850. The collection was named by Hooker and included in his *Flora Boreali-Americana*.

1870 – The Red River Settlement was organized as the Province of Manitoba.

1879 – Robert Bell, pioneer Canadian geologist, made a plant collection at Churchill. This and other collections made by Bell along the Churchill, Nelson, and Hayes rivers and the coast of Hudson Bay were determined by John Macoun, founder of the National Herbarium of Canada, who, in 1882, was appointed first botanist to the Geological Survey of Canada. The latter had been organized in 1842, with Sir William Logan, father of Canadian geology, as Director.

1885 – Canadian Pacific Railway spans the continent.

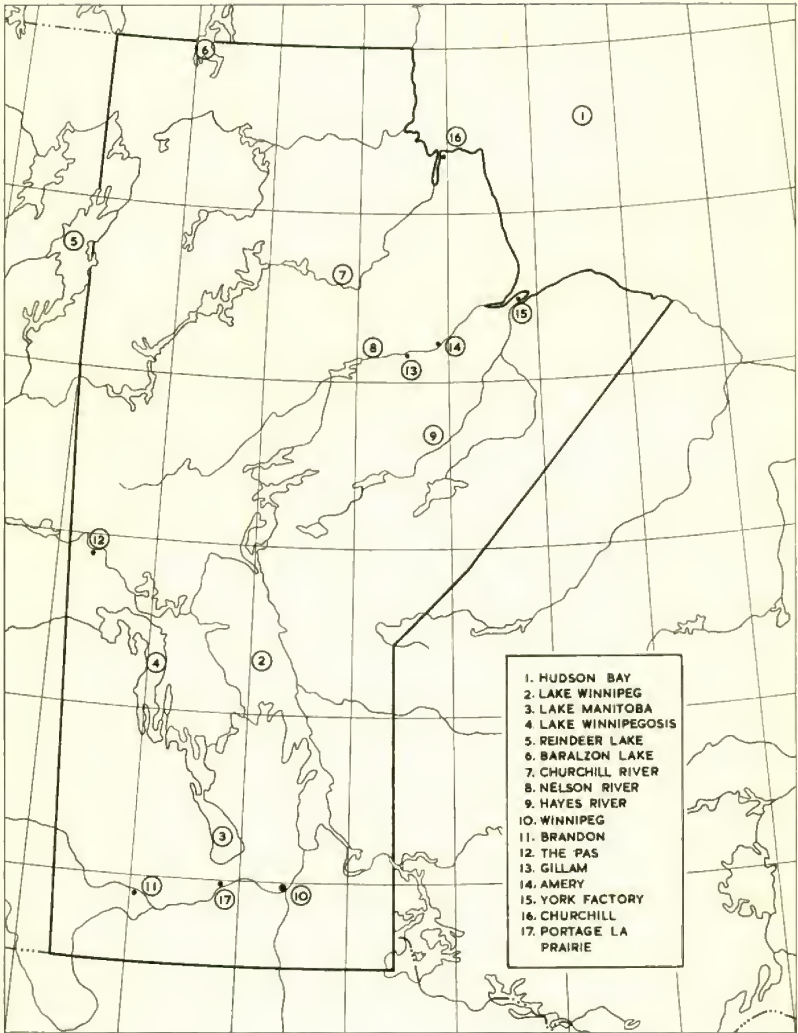
1893–94 – J. B. Tyrrell, famous Canadian geologist, studied the geology of the Churchill area following his return from Lake Athabasca via Chesterfield Inlet.

1900 – E. A. Preble made a biological investigation of the west coast of Hudson Bay. His report (1902) includes general notes on the vegetation.

1911 – Letting of the contract for the first 185 miles of grading on the Hudson Bay Railway between The Pas and Churchill.

1912 – Extension of the boundaries of Manitoba to the sixtieth parallel and to the shores of Hudson Bay to include about half the former area of the District of Keewatin.

1931 – Completion of the Hudson Bay Railway. It had been planned originally that the terminus should be Port Nelson, at the mouth of Nelson River, and by 1918 the right-of-way had been cleared and graded to this point, when construction work at Port Nelson was stopped because of a shortage of ships and material following the war. In 1927, work was resumed, and the track was completed to Mile 356, at which point the swing was made north to Churchill, the harbour of which provides a natural haven in the roughest of seas. Nelson River, unlike the Churchill, is subject to heavy silting. It had been feared that the foundation of the seventy-five-mile stretch over frozen muskeg south of Churchill would soften under the summer sun and absorb the roadbed, but trials showed that a substantial gravel fill on top of the muskeg acted as an efficient heat insulator, preventing the foundation from giving way. The grain elevator and port at Churchill were also completed in 1931. They are operated by the National Harbour Board, a branch of the Department of Transport. The harbour is open to shipping approximately four months of the year, exports consisting of grain, flour, lumber, and cattle, and imports ranging from automobiles to chinaware and glass. The grain elevator is one of the most modern and has a storage capacity of two and one-half million bushels.



MAP OF MANITOBA

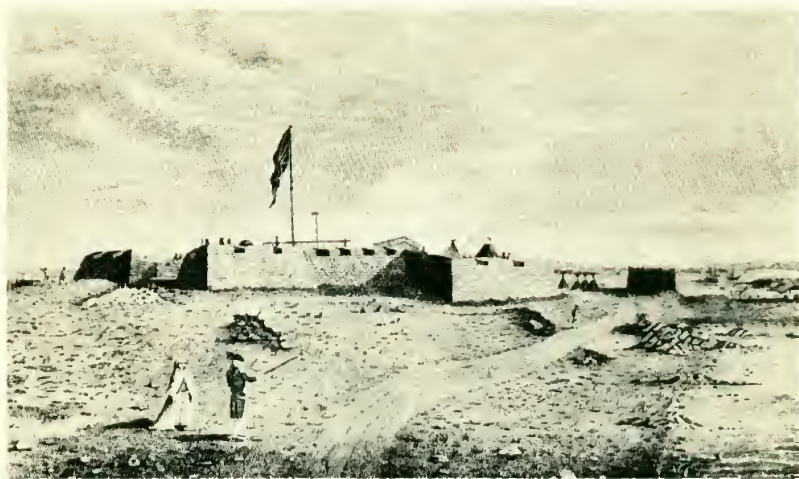
PHYSICAL FEATURES OF MANITOBA, WITH SPECIAL REFERENCE TO THE
HUDSON BAY AREA

The province of Manitoba extends for a distance of 750 miles between the forty-ninth and sixtieth parallels of latitude. Its greatest width is approximately 480 miles, at about the fifty-seventh parallel. Its total area is approximately a quarter of a million square miles, of which, however, only the section south and west of Lake Winnipeg is suitable for agriculture. Mining, trapping, fishing, and lumbering are important industries in the central and low-northern regions.

An excellent account of the geological formations of Manitoba is given by Wallace (1925), who notes the occurrence of five main groups, namely: Precambrian granites, gneisses, lavas, and sediments; Ordovician, Silurian, and Devonian limestones, dolomites, sandstones, and shales; and Cretaceous shales. The approximate extent of the five major formations is shown by Wallace in his Plate VIII, p. 36.

The southwestern boundary of the Precambrian extends from the southeastern corner of the province up the long axis of Lake Winnipeg (an erosion lake between the Precambrian and the overlying limestones), and turns westward to the Saskatchewan boundary at about the fifty-fifth parallel. The northeastern boundary follows the coast of Hudson Bay from the sixtieth parallel to the neighbourhood of Churchill, from where the Precambrian-Ordovician contact extends in a generally southward direction to the Nelson River near Gillam, thence southeastward to the Hayes River, and east to the Ontario boundary at about latitude 55° 40' N.

Relatively narrow bands of Ordovician and Silurian formations parallel the two Precambrian boundaries, those to the northeast forming the Hudson Bay Lowlands, those to the southwest, together with an adjacent band of Devonian rocks, forming the Manitoba Lowlands (sometimes referred to as the "first prairie steppe"). To quote Wallace, "The southwestern part of Manitoba, north to the latitude of Dawson Bay, Lake Winnipegosis, which comprises about one-tenth of the area of the province,



Fort Prince of Wales in the early days.

is a region of elevations in general between 1,300 and 1,400 feet, underlain by Cretaceous shales, and is known as the 'second prairie steppe'. It is separated from the lower first prairie steppe to the east by the Manitoba Escarpment, a chain of hills and low mountains trending in a north-northwesterly direction. These are Pembina Mountain, Tiger Hills, Riding Mountain, Duck Mountain, and Porcupine Mountain, with a continuation into central eastern Saskatchewan known as the Pasquia Hills."

Because of intense erosion, rocks of Tertiary age occur in Manitoba only, so far as known, on Turtle Mountain, an outlier of the extensive Tertiary deposits of southern Saskatchewan. The Missouri Coteau, Wood Mountain, and Cypress Hills are prominent features of this third or western prairie steppe.

The topography of the province, of which the highest elevation is the 2,727-foot peak Baldy of Duck Mountain, has been influenced not only by the character of the bedrock but also by glacial and postglacial phenomena. Upon the gradual recession of the Wisconsin ice-sheet following the Pleistocene glaciation, a large body of fresh water was left covering the entire Manitoba

Lowlands, extending at its maximum to approximately the fifty-fifth parallel and covering the upper part of the present Nelson River system. This forerunner of the present-day lakes Winnipeg, Manitoba, and Winnipegosis is known as Glacial Lake Agassiz. It was preceded by the much smaller Glacial Lake Souris on the Cretaceous plateau to the southwest, this lake originally draining southward by way of the lower levels of the present Souris Basin west of Turtle Mountain, but later draining eastward into youthful Lake Agassiz by way of the present-day Pembina River channel. The flat, smooth topography of the Manitoba Lowlands is the result of the deposition of silts and clays in Lake Agassiz, which, during its various phases of drainage, established the many beaches now traceable along the Manitoba Escarpment as gravel ridges or wave-cut terraces. According to Upham (1890), the waters of Lake Agassiz at the time of the formation of its highest beach covered the present site of Winnipeg to a depth of about 600 feet.

Until recently it has been generally assumed that the time elapsed since the last glacial maximum of the Wisconsin ice-sheet is in the neighbourhood of 25,000 years, and that the north-eastward drainage system of Lake Agassiz into Hudson Bay, upon the melting of the northern ice barrier, was established approximately 9,000 years ago. Flint and Deevey (1951), however, report that radiocarbon measurements of wood from the Two Creeks peat formation immediately underlying the Mankato drift in Wisconsin give the age of the wood as only about 11,000 years, a result that "seems to have been anticipated by the opinions of some geologists and soil scientists, who had come to believe that the degree of soil development and erosion on the Mankato drift are inconsistent with an age as great as 25,000 years... The whole process of deglaciation seems to have been more rapid than had been supposed." In Manitoba, then, the period available since Pleistocene times for colonization of extensive parts of the land by plants may eventually prove to be of the order of only four or five thousand years. The presence of a former great lake in the Red River basin of Manitoba was first noted by Palliser (1863, p. 41), in the following words: "This plain, no doubt, had formed at one time the bed of a sheet of water, and Pembina

Hill, consisting of previously-deposited materials, was its western shore." For further accounts of Lake Agassiz, the following may be consulted: Upham (1895); Wallace (1925); Antevs (1931); Leverett (1932); and Johnston (1946). An excellent account of the Pleistocene geology of southwestern Manitoba is given by Elson (1954).

Coombs (1954) describes the continental part of the Hudson Bay Lowlands as "a flat, swampy plain with a slight downward slope toward its coastal regions along James and Hudson Bays", located on the west side of the latter bays between Nottaway River in Quebec and Churchill River in Manitoba. Churchill is situated at the northwestern extremity of the "Coastal Zone" bordering the bays. A narrow "Dry Zone" occurs to the west and



S. Hearne's name on the smooth glaciated rock at Sloop's Cove, near Churchill.

south of the James Bay Coastal Zone, and still farther west is a "Muskeg and Small Lake Zone", extending northward to Severn River. That part of the Lowlands between the Severn and Churchill rivers, exclusive of the narrow Coastal Zone, is termed the

"Marine Clay Zone". The one hundred and seventy-five mile north-south stretch of the Hudson Bay Railway between Amery and Churchill is located in this last zone.

The Marine Clay Zone "is so named because of the widespread mantle of marine clay deposited during the postglacial submergence of the lowland....Much of the zone is covered with a complex network of sluggish dendritic streams, which, however, eventually link up with some main drainage channel leading to the sea. There are areas, however, that are almost completely undrained, the water merely overflowing in periods of thaw or rain from one water-hole to the next until some stream is reached. Such areas are covered by extensive peat bogs, for the most part barren of tree growth of any kind."

An outstanding feature of the Coastal Zone is the occurrence of broad tidal flats extending seaward for miles from high-water mark. "Low ridges are another feature of the lowland's shoreline....The ridges appear to develop from offshore bars. By repeated wave action, aided by apparent continued crustal uplift in the region and a gentle slope of the sea floor — 1 foot in 200 or 300 yards — these bars are slowly pushed toward the shore."

The aerial photographs of Coombs (1954, Fig. 12, Cape Tatnam area) and Scoggan (1951, Pl. 28 and 1957, Pl. 1) illustrate by their patterns of raised shore lines the well known fact that there has been considerable uplift along the west coast of Hudson Bay following removal of the ice load, estimated by Williams (1948) as over 9,000 feet in thickness. Marine shells have been found in these beaches between elevations of 200 to 500 feet. Regular lines of driftwood are found at levels well above the highest tides, and Williams reports the finding of a walrus skeleton a considerable distance inland, about 43 miles south of Churchill. Furthermore, the lower stretches of the major rivers are characterized by swift currents and steep banks cut through marine clays, limestones, and dolomites.

Whether or not the land is at present rising at an appreciable rate is another question. Gutenberg (1942), Flint (1952), and Lougee (1953) support the view of Bell (1898) that uplift is

still progressing at the rate of 5 to 10 feet per century. Among other points, Bell cited the following: (1) old navigation records, and the increasing difficulty of reaching trading posts along the Bay by boat; (2) the well-preserved nature of shells of moderately deep-water species of molluscs in the clay shores of James Bay; (3) the drying up of salt-marsh feeding grounds of ducks and geese within memory of living man; (4) the appearance of trees on river islands during the same period; (5) the presence northward of remains of Eskimo beach dwellings up to elevations of 70 feet; (6) the present inappropriateness of many of the aboriginal place-names of James Bay. On the other hand, Tyrrell (1896; 1913), Johnston (1939), Cooke (1942), and Williams (1948) are of the opinion that there has been relatively little uplift within historic time.

It has already been noted that the Hudson Bay Lowlands of Manitoba is an area of Silurian and Ordovician formations. Of particular interest is the occurrence along the coast at Churchill of rocky ridges of "Churchill quartzite." In the words of Williams (1949), the geology of Churchill "was predetermined in Precambrian time when the sand of the Churchill quartzite was deposited in a geosyncline or unstable basin. This is estimated as more than six hundred million years ago. After the sand was compacted into rock, great compressive forces in the earth's crust thrust it into folds, anticlines and synclines. Subsequent erosion removed higher and softer beds from the geosyncline to form the valley of the ancestral Churchill river. Shallow seas of later Ordovician time flooded the area, laying down their white dolomitic muds and in early Silurian seas reef corals fastened themselves to quartzite ridges. No legible records remain of later Paleozoic, Mesozoic or early Tertiary time." As the Wisconsin ice-sheet of Pleistocene time melted, "it was replaced by water in the great Hudson Bay Basin, which was then much larger than now. The plastic crust of the earth gradually adjusted itself to the lessening load and rose some 350 feet or more, leaving raised beaches and remains of sea shells far inland. The great cold of the ice age and the long post-glacial winters drove the frost line deep into the gravels and sands resulting in the 'permafrost' of today. The interior continental climate, the arctic

currents which sweep anti-clockwise around Hudson Bay, and its frozen condition for seven months of the year, explain the southerly dip of the tree line and the summer isotherms."

According to Ritchie (1956), most of the Churchill area "is covered by till of Pleistocene age, consisting of silt, calcareous clay and pebbles, boulders, and rock flour. The land which is covered by this till is flat or gently sloping, forming the vast plains of much of Northern Manitoba and Keewatin, broken only by outcrop ridges, eskers, moraines, raised beaches, and shore lines."

CLIMATE OF CHURCHILL

Tables I and II have been compiled from Volume 1 of "Climatic Summaries for Selected Meteorological Stations in the Dominion of Canada," issued by the Meteorological Division of the Department of Transport, Canada. The localities chosen are indicated by the following numbers: (1) Winnipeg; (2) Brandon; (3) Swan River, north of Duck Mountain; (4) Berens River, about the middle of the east coast of Lake Winnipeg; (5) The Pas; (6) Norway House; (7) Port Nelson, and (8) Churchill.

TABLE I
MONTHLY AND ANNUAL AVERAGES OF DAILY MEAN TEMPERATURE

(degrees Fahrenheit)

	1	2	3	4	5	6	7	8
Years obs.	66	29	11	19	27	40	11	30
January	-3	-3	-6	-8	-9	-11	-17	-19
February	2	1	-6	-3	-2	-4	-14	-17
March	16	16	9	10	11	9	2	-6
April	38	38	39	31	33	29	17	14
May	52	51	49	56	48	45	33	30
June	62	60	59	58	59	57	45	43
July	67	65	64	63	65	63	55	54
August	64	62	61	60	61	60	53	52
September	54	53	51	50	49	48	44	42
October	41	40	38	36	35	36	30	27
November	22	21	18	19	17	16	10	6
December	6	6	2	0	1	-2	-9	-11
Annual Average	35	34	31	30	31	29	21	18

TABLE II
AVERAGE MONTHLY AND ANNUAL PRECIPITATION
(inches)

	1	2	3	4	5	6	7	8
Years obs.	66	29	11	20	27	40	11	30
January	0.92	0.73	0.63	0.79	0.61	0.69	0.60	0.48
February	0.86	0.58	0.65	0.75	0.50	0.78	0.46	0.61
March	1.19	0.76	1.14	1.00	0.72	1.01	0.58	0.87
April	1.37	0.99	0.79	0.92	0.81	0.74	0.88	0.89
May	2.26	1.62	1.52	1.41	1.38	1.08	0.85	0.93
June	3.15	2.77	3.41	2.49	2.20	1.93	2.07	1.85
July	3.08	2.37	2.80	2.25	2.22	2.29	1.64	2.19
August	2.45	2.18	2.27	1.99	2.11	2.38	2.08	2.69
September	2.35	1.52	1.78	2.94	1.96	1.85	1.79	2.33
October	1.49	0.83	0.82	1.62	1.16	0.93	0.96	1.43
November	1.12	0.79	1.13	1.31	0.98	1.07	1.04	1.03
December	0.95	0.59	0.98	1.02	0.79	0.83	0.81	0.66
Annual Average	21.19	15.73	17.92	18.49	15.44	15.58	13.76	15.96

Of the annual average precipitation of 15.96 inches at Churchill, 10.27 inches was in the form of rain, the remainder resulting in an annual average of 56.9 inches of snow.

According to Cheney and Beckel (1955), the possible hours of sunshine for Fort Churchill during the winter months range from slightly over six hours in December to over twelve hours by the end of March. Cloud cover and haze normally reduce these lengths considerably.

During a fifteen-year period of observation at Churchill, the average monthly maximum temperature for July, the warmest month, was 82 degrees Fahrenheit, and the average of the fifteen maximum temperatures (irrespective of the month in which they occurred) was 84 degrees. The highest temperature recorded was one for July of 96 degrees. The average monthly minimum temperature for January, the coldest month, was -40 degrees, and the average of the annual minimum temperatures (irrespective of month) was -42 degrees. The lowest temperature recorded was one for January of -57 degrees.

The average daily mean temperature (based on twenty-four hourly observations daily) of 54 degrees for July shown in Table I places Churchill significantly south of the 50°F. (10°C.) July isotherm, believed by some biologists and geographers to be a suitable indicator of the southern limit of the true Arctic. This isotherm, shown in Chart 1-5 of Thomas (1953), lies in most places considerably north of the polar limit of tree-like conifers shown in Figure 7 of Hustich (1953). A much closer correspondence with the northern tree line is attained by the "Nordenskjöld line" shown in Figure 1 of Polunin (1951) and Figure 1 of Hare (1951). The formula upon which this isotherm is based employs not only the factor of mean temperature of the warmest month but also that of mean temperature of the coldest month for the localities through which it is drawn. Hare notes that Tierra del Fuego, at the southern tip of South America, is forested in spite of the fact that the average temperature of the warmest month is only between 46-50°F., presumably because mean daily temperatures throughout the winter remain above freezing. Apparently a truer reflection of the influence of temperature upon growth is given by the combined use of summer and winter temperatures than by the use of the former only.

Sanderson (1948) has outlined the climates of Canada according to Thornthwaite's revised classification (1948), placing Churchill in the humid, cool microthermal zone, with an evapotranspiration value of 12.6 inches (32 cm.). Potential evapotranspiration is the combined evaporating power of the vegetation and a soil surface in which the supply of moisture is unlimited. It is expressed as a function of day length as well as of temperature and is used as a measure of the thermal efficiency of a region. It was Thornthwaite's belief that, in the cold climates, restriction of growth by cold far outweighs the effect of scanty precipitation, moisture normally not being a limiting factor for plant growth in arctic and subarctic regions. This belief is supported by tree-ring studies of Hustich (1949) in Scandinavia, Giddings (1941; 1947) in Alaska and District of Mackenzie, and Marr (1948) in the Richmond Gulf area on the east coast of Hudson Bay. A remarkable uniformity of ring width

and freedom from incomplete or stunted rings, such as often occur in areas subject to drought, was noted in all cases. This uniformity of ring width is presumably correlated with the fairly uniform mean monthly temperatures, precipitation or ground water being sufficient to meet the very limited demands of plant growth.

Wind velocity at Churchill exerts a pronounced effect upon tree growth and, in combination with low temperatures, may be sufficient to explain the stunted growth of trees there and at other localities such as the coast of Labrador. The most frequent direction of wind, according to Chart 3-10 of Thomas (1953), is from the northwest, and the next most frequent direction is about equally from the north, west, and south. A transverse section of a black spruce from Churchill was found by Williams (1950) to have growth rings dating back to the year 1650. It had an average diameter of 10 inches, taken 56 inches above the ground from a tree 22 feet tall with a basal diameter of about 14 inches. The roots rested on permafrost, and surface seepage provided abundant moisture during the growing season. The one variable was obviously temperature, but few rings were incomplete and no double rings were recognized, indicating that thermal efficiency was adequate. On the other hand, the sweep of the branches and top reflected the direction of the prevailing westerlies, as did also the fact that the central pith was located off-centre at a position almost exactly one-third of the diameter from the side of the tree that had faced west, the growth rings being consistently wider on the east side. Wind velocity is undoubtedly a factor to be taken account of in regions where "it takes two trees to make a Christmas tree." The explanation may be that, although supplied with sufficient moisture for the purposes of normal transpiration, the increased transpiration on the exposed side as opposed to the sheltered side results in enough desiccation, combined with low temperature, to kill exposed branches, reducing the food supply to that part of the tree. According to Cheney and Beckel (1955), windchill, or the loss in kilogram calories as influenced by wind velocity, is frequently well above 2000 and as high as 2500 at Churchill when the temperature is below -30°F. , compared with average windchills in January of 780, 1200, and 1450 on airfields at Vancouver, Ottawa, and Winnipeg, respectively.

The presence or absence of permafrost may have an important bearing on plant growth. Permafrost is of general occurrence throughout the cool microthermal zone, as indicated by Jenness (1949, Map 1). According to Johnston (1930), the depth of permanently frozen ground at Port Nelson averages about 30 feet, and at Churchill ice has been found in cracks of the bedrock at a bore depth of 146 feet. According to Jenness, permafrost seems to affect vegetation mainly in two ways. First, where the non-frozen "active" layer of soil is thin, shallow-rooted tree species such as black spruce, white spruce, larch, and balsam poplar may grow, but deep-rooted species are excluded. Black spruce and larch also seem to be able to form auxiliary roots if their bottom roots are killed. Secondly, by providing an impervious base to subsurface water, permafrost confines drainage to the shallow active layer, producing extensive areas of low-lying muskeg dominated by the water-tolerant black spruce, with larch as a common associate. White spruce and balsam poplar are confined to the higher, better-drained sites. As aptly expressed by Ritchie (1956), "It is possible that, within the wider limits directly imposed by climatic factors, such edaphic factors as the presence of permafrost might determine the precise configuration of the tree line". Ritchie (1957) has illustrated diagrammatically the relationship between permafrost and topography at Churchill. Wet depressions in a forested area east of the Churchill River estuary alternate with peat hummocks or small mounds overlying vertical extensions of permafrost. It is suggested by Ritchie that the formation of an insulating peat layer following colonization of the original calcareous glacio-fluvial mineral deposits by meadow and shrub phases of the vegetation raised the level of the perennially frozen layer and that the resulting poor drainage produced the hummock-hollow topography.

Ideally, in a region where moisture supply is not a limiting factor for plant growth, the tree line should extend northward to a boundary beyond which thermal efficiency is too low to support tree growth. However, it is generally recognized that climates are not yet static after the great disturbances of the Ice Age and that vegetation boundaries, too, are on the move, following in the wake of migrating climatic belts. Griggs (1937) notes that in southwestern Alaska the 50°F. (10°C.) isotherm for the warmest month stands

250 miles beyond the edge of the forest. Marr (1948), as a result of field observations in the Richmond Gulf area on the east coast of Hudson Bay, concluded that "Areas unsuitable for trees because of absence of soil are occupied by tundra. Trees are invading tundra areas as soil develops." Hustich (1953) notes that there has been a fairly well-marked amelioration of the climate of the forest-tundra region of northern Eurasia during the last few decades but is doubtful that the same can be said for Eastern Canada. However, since the mean annual temperature of the Richmond Gulf area is only two or three degrees higher than that at Churchill (Jenness, 1949, Map 2; Thomas, 1953, Chart 1-9) and the mean July daily temperature at Churchill is indicated as somewhat higher than at Richmond Gulf (Thomas, 1953, Chart 1-5), it is probable that essentially the same factors are in operation at both localities. Ritchie (1957) is of the opinion that there is clear evidence in an area east of the Churchill River estuary that "the white spruce forest is invading the younger, shrub-dominated flats, and that it is ultimately replaced by a black spruce community on large peat mounds."

Variations in soil temperature may help to explain local tree distribution. Beckel (1954) found that greater extremes in temperature occur at or near the surface of soil in higher, drier areas than in lower, wetter areas. The accumulation of snow by drifting from higher to lower areas also serves to insulate the lower areas against extreme lowering of soil temperatures. Beckel (1957) found that in areas where there was a great accumulation of snow during the early part of the winter or where the upper limit of permafrost occurred at great depths, as in wet, sandy soils, the lower levels of the active soil layer rarely reached freezing temperatures.

Another way in which low temperature affects vegetation is the disturbing action of frost on the active ground layer. "Drunken forest" phenomena are particularly noticeable along the banks of the Hayes, Nelson, and Churchill rivers where thawing of the marine clays has resulted in mass movement of the substratum. Their occurrence on level areas is believed to result from the expansion of frost mounds under them in much

the same way as has been noted above for peat hummocks and mounds. The powerful effect of frost-heaving can be seen at Churchill, where angular blocks of quartzite have been raised a considerable distance from their original position in the bed-rock. Soil polygons have been found in the treeless region a few miles south and north of Churchill. It is probable that the ridges commonly marking the margins of lakes and ponds are caused by expansion of surface ice in winter.

Temperature is, of course, of foremost importance in determining the length of the shipping season at Churchill. The average date at which ice goes out of Churchill harbour is about June 15th, and the average of open water is about five months.

The climate of Churchill is partly determined by winter ice conditions in the Bay. As late as 1941, Bajkov (1941) stated that "Many people think that Hudson Bay and Strait are solidly frozen over during the winter months. This is not true, however, for the main body of water in this vast inland Canadian sea is constantly open." According to Montgomery (1951), however, "If Hudson Bay remained open all winter, the warming effect which such a huge body of water would have on the cold polar air flowing across it would be clearly evident in the temperatures and the amount of cloudiness of the surrounding areas. If, on the other hand, the Bay were frozen over, it would act as an extension of the cold snow-covered land and, in the long hours of winter darkness, would add its chilling effect to the Arctic winds which sweep predominantly south and southeastwards over the region. Certainly all existing reports from the whalers and explorers who have wintered there claimed that it was an area of open water, but the climatic research carried out at McGill showed little in the weather records to support such an opinion and much to contradict it."

Following establishment of a large air base on Southampton Island at the northern limits of the Bay in 1942, reports of those who had flown over the area gradually strengthened the belief that the entire Bay, except for shore leads kept open by tidal action, was completely ice-covered. Observations and photographs made by Montgomery (1951) during the not exceptionally cold winters of 1948 and 1949 showed beyond a doubt that the

Bay was completely frozen over. As pointed out by Montgomery, early whalers and travellers who wintered around the Bay usually did so in frozen inlets along the western and northwestern coasts, in the vicinity of the widest and most persistent section of the Hudson Bay shore lead. The "sea-smoke" formed by vapour condensing in the cold air above the lead would blot out the eastern horizon, giving the impression that the open water extended indefinitely across the Bay. On one flight, Montgomery encountered sea-smoke 50 miles east of a shore lead only 5 to 10 miles wide. Because all coastal anchorages were ice-bound, there is no record of any ship having attempted to make a winter crossing of the Bay, thereby disclosing the actual facts.

The preceding discussion raises the question of whether Churchill is better placed in the low arctic or the high subarctic zone. The Nordenskjöld line passes through Churchill, but it is also indicated as passing through Port Nelson and York Factory, neither of which localities can be claimed to have an arctic climate or vegetation. The 50°F. isotherm for the warmest month passes north of Churchill at a point about midway to Chesterfield Inlet. The fact that some success can be had with the growth of cultivated vegetables points to a subarctic rather than an arctic climate. Bell (1880) reports very good potatoes and turnips growing in a garden, and Beckel (1954) reports near to normal growth and development with such short season vegetables as chives, onions, garlic, lettuce, peas, broccoli, parsley, swiss chard, and cress.

In Table III are shown the latitudinal subdivisions into which the 354 native species of vascular plants of the Churchill area have been grouped (see below). For purposes of comparison, the 322 native species cited by Porsild (1957) from the Canadian Arctic Archipelago are also subdivided on this basis. The writer's work during the past few years on the flora of the Canadian Atlantic seaboard reveals the presence in the southern half of coastal Labrador (exclusive of the Strait of Belle Isle area) of approximately 506 species. Comparison of the figures for Churchill and southern coastal Labrador indicates a close conformity to what would be expected on a climatological basis, and the native floras of these two areas give convincing evidence of a subarctic rather than an arctic climate.

TABLE III
LATITUDINAL EXTENSIONS OF NATIVE SPECIES

Latitudinal subdivision	Can. Arct. Arch.		Churchill		Coastal S. Lab.	
	Native species (322)	Per cent of native species	Native species (354)	Per cent of native species	Native species (506)	Per cent of native species
High-arctic	132	41.0	58	16.4	54	10.7
Low-arctic	124	38.5	71	20.0	63	12.5
High-subarctic	66	20.5	134	37.9	177	35.0
Low-subarctic	—	—	91	25.7	203	40.1
Temperate	—	—	—	—	9	1.7

FLORA AND VEGETATION OF THE CHURCHILL AREA

The 354 native species of vascular plants of the Churchill area are listed below, together with symbols denoting their geographical ranges. The checklist is based upon collections made in the area by persons named by Scoggan (1957, p. 4). Specimens are filed in the herbarium of the National Museum of Canada, Ottawa; the Plant Research Institute of the Department of Agriculture, Ottawa; and the Department of Botany, University of Manitoba, Winnipeg. In assigning species to their respective subdivisions, much help has been derived from a set of distribution maps compiled by A. E. Porsild, Chief Botanist at the National Museum.

The northern limits of the latitudinal subdivisions in Canada and Greenland are approximately as follows, due allowance being made in individual cases for local areas of warmer microclimates such as the upper Hamilton River basin of south-central Labrador (see Fig. 11 of Hare (1950)), hot spring areas in Alaska, and the generally less extreme fluctuations of temperature in strictly aquatic habitats:

Low-subarctic: the northern boundary follows approximately the 55°F. (12.8°C.) July isotherm of mean daily temperature from northern Newfoundland and southern Labrador to central James Bay, north-central Manitoba, Great Slave Lake, Great Bear Lake, and southern Alaska; southernmost Greenland.

High-subarctic: the northern boundary is taken to include the ranges of species more northern in distribution than the preceding but not found in the Canadian Arctic Archipelago, except perhaps in southern Victoria and Banks islands and warmer microthermal areas of Baffin Island south of the Arctic Circle. In some areas it follows closely (in others extending considerably farther north of) the polar limit of tree-like conifers shown in Figure 7 of Hustich (1953), the Nordenskjöld line shown in Hare (1951) and Polunin (1951), and the July isotherm of 45°F. (7.2°C.) shown in Chart 1-5 of Thomas (1953); West Greenland to about latitude 70°N. and East Greenland to about latitude 65°N. (see Böcher, 1938, Fig. 2).

Low-arctic: this subdivision includes the islands of the Canadian Arctic Archipelago (with the above exceptions) north to the southern parts of Devon, Cornwallis, Bathurst, and Melville islands, and warmer microthermal areas along the east and west coasts of Ellesmereland. It is taken to include those areas north of the high-subarctic subdivision that lie south of or are in northern outliers of the 40°F. (4.4°C.) July isotherm shown in Figure 11 of Rae (1951) and Figure 3 of Porsild (1955); Greenland for varying distances north of latitude 70°N., but rarely north of latitude 76°N.

High-arctic: areas north of the low-arctic subdivision or not isolated by outlying 40°F. isotherms.

In some doubtful cases, the northern limit in Eurasia has served as a basis for assigning certain circumpolar species to the subdivision considered most suitable, but it must be emphasized that this classification cannot be resolved into a purely mechanical sorting out of plant ranges according to the above boundaries. The general pattern of distribution of each species must be borne in mind, as well as the distribution of local microclimates.

The distribution in North America and Greenland of all the high-arctic and low-arctic plants listed has been mapped by Porsild (1957), who has also done the same for many of the high-subarctic species. Many of the species have also been mapped for North America and Greenland by Raup (1947). The world distribution of the amphi-Atlantic species (plants with their main areas on both sides of the Atlantic Ocean) has been mapped by Hultén (1958), with the exception of the doubtfully amphi-Atlantic *Polygonum boreale* (Lange) Small. References to maps of many of the low-subarctic species, as well as to those of the other subdivisions, are given by Scoggan (1957). Previous publications referring to the flora and vegetation of Churchill are as follows: Beckett (1945); Bell (1880); Gardner (1937); Gillet (1948); Grøntved (1936); Güssow (1933); Johansen (1933); Macoun (1911); Rae (1850); Ritchie (1956; 1957); Scoggan (1957); Størmer (1933); Tyrrell (1897). Thomson (1953) has listed the lichen flora of the area. (The following publications refer to the animal life of the area: Taverner and Sutton (1934); Beckett

(1951); Williams (1950); Preble (1902); McClure (1943); Shelford and Twomey (1941).)

Names preceded by an asterisk (*) indicate species not listed for Churchill by Ritchie, who (1956) cited 272 species from the area, later (1957) adding *Festuca rubra*, *Puccinellia paupercula*, *Carex canescens*, *C. stans*, and *Aster puniceus*. The increase to the present number of 354 has resulted from a listing of Churchill specimens in the National Herbarium of Canada, particularly those collected during the summer of 1956 by W. B. Schofield and H. A. Crum, and several noteworthy additions by Mrs. Eva Beckett.

Of the 277 species cited by Ritchie from Churchill, three (*Salix anglorum*, *S. desertorum*, and *S. adenophylla*) have been dropped from the following lists as being of too uncertain occurrence in the area to warrant inclusion. *Urtica gracilis* has also been dropped, it being undoubtedly introduced. *Poa pratensis* has been excluded, its native representative at Churchill being *P. alpigena*. Other changes are as follows (the names used by Ritchie appearing in brackets): *Puccinellia pumila* (*P. paupercula*); *Salix planifolia* (*S. pellita*); *Draba luteola* (*D. minganensis*); *Braya novae-angliae* var. *interior* (*B. humilis*); *Potentilla pensylvanica* var. *pectinata* (*P. pensylvanica*); *Oxytropis terrae-novae* (*O. johannensis*); *Kalmia polifolia* (*K. latifolia*); *Castilleja raupii* (*C. pallida* ssp. *elegans*); *Achillea borealis* (*A. millefolium* var. *nigrescens*). Three of the above (*Salix planifolia*, *Castilleja raupii*, and *Achillea borealis*) are listed by Ritchie in addition to the species here replaced. *Cystopteris dickieana* is here treated as a variety of *C. fragilis*, and *Salix callicarpaea* as a variety of *S. cordifolia*, excluding *C. dickieana* and *S. cordifolia* var. *tonsa* from the species list because of the presence at Churchill of the typical form or an additional variety. These sixteen deletions, together with the addition of the 93 new species denoted by asterisks in the following lists, yield the final figure of 354.

The numbers of species in the various latitudinal subdivisions are as follows:

<i>HAC</i>	High-arctic circumpolar	44
<i>HAX</i>	High-arctic amphi-Atlantic	5
<i>HAA</i>	High-arctic American	9
<i>LAC</i>	Low-arctic circumpolar	48
<i>LAX</i>	Low-arctic amphi-Atlantic	11
<i>LAA</i>	Low-arctic American	9
<i>LAEA</i>	Low-arctic eastern American	1
<i>LAWA</i>	Low-arctic western American	2
<i>HSC</i>	High-subarctic circumpolar	66
<i>HSX</i>	High-subarctic amphi-Atlantic	6
<i>HSA</i>	High-subarctic American	54
<i>HSEA</i>	High-subarctic eastern American	1
<i>HSWA</i>	High-subarctic western American	7
<i>LSC</i>	Low-subarctic circumpolar	27
<i>LSX</i>	Low-subarctic amphi-Atlantic	3
<i>LSA</i>	Low-subarctic American	56
<i>LSEA</i>	Low-subarctic eastern American	3
<i>LSWA</i>	Low-subarctic western American	2

- Equisetum arvense* L. var. *boreale* (Bong.) Ledeb. HAC
 **E. palustre* L. HSC
E. fluviatile L. HSC
E. variegatum Schleich. HAC
E. scirpoides Michx. HSC
Lycopodium selago L. (repr. by var. *appressum*) HAC
L. annotinum L. var. *pungens* (La Pylaie) Desv. LAC
L. complanatum L. HSC
Selaginella selaginoides (L.) Link HSC
Botrychium lunaria (L.) Sw. HSC
 (var. *minganense* (Vict.) Dole also present)
Cystopteris fragilis (L.) Bernh. HAC
 (var. *dickieana* (Sim) Moore also present)
Dryopteris disjuncta (Ledeb.) C.V. Mort. HSC
 **Polypodium virginianum* L. LSA
Picea glauca (Moench) Voss HSA
P. mariana (Mill.) BSP. HSA
Larix laricina (DuRoi) K. Koch HSA
Juniperus communis L. var. *saxatilis* Pallas HSC
 (var. *depressa* Pursh also present)
Sparganium angustifolium Michx. HSC
S. hyperboreum Laestad. HSC
Potamogeton filiformis Pers. LAC
 (var. *borealis* (Raf.) St. John also present)
 **P. vaginatus* Turcz. LSC
P. alpinus Balbis var. *tenuifolius* (Raf.) Ogden HSA
P. gramineus L. HSC
 **P. friesii* Rupr. HSC
 **Zostera marina* L. var. *stenophylla* Aschers. & Graebn. LSC
Triglochin maritima L. HSC
T. palustris L. HSC
 **Bromus pumpellianus* Scribn. HSWA
Festuca rubra L. HSC
F. brachyphylla Schultes HAC
 **F. vivipara* (L.) Sm. HSX
Puccinellia lucida Fern. & Weath. LSA
P. langeana (Berl.) Th. Sør. LAA
 **P. vaginata* (Lge.) Fern. & Weath. LAA
 (var. *paradoxa* Th. Sør. also present)
 **P. pumila* (Vasey) Hitchc. HSA
 **P. nuttalliana* (Schultes) Hitchc. LSWA
P. phryganodes (Trin.) Scribn. & Merr. HAC
 **Glyceria striata* (Lam.) Hitchc. var. *stricta* (Scribn.) Fern. LSA
Poa arctica R. Br. HAC
 (ssp. *caespitans* (Simm.) Nannf. also present)

- **P. alpigena* (Fr.) Lindm. f. LAC
- P. glauca* M. Vahl HAC
- P. alpina* L. LAC
- **P. palustris* L. LSC
- **Catabrosa aquatica* (L.) Beauv. HSC
- **Dupontia fisheri* R. Br. ssp. *psilosantha* (Rupr.) Hult. LAC
- **Arctophila fulva* (Trin.) Rupr. LAC
- Agropyron latiglume* (Scribn. & Sm.) Rydb. HAA
- Elymus innovatus* Beal HSWA
- E. arenarius* L. ssp. *mollis* (Trin.) Hult. LAC
- Trisetum spicatum* (L.) Richter HAC
- (var. *maidenii* (Gand.) Fern. and var. *molle* (Michx.)
- Beal also present)
- Deschampsia caespitosa* (L.) Beauv. var. *ittoralis* (Reut.)
- Richter HSC
- **Alopecurus alpinus* L. HAC
- Arctagrostis latifolia* (R. Br.) Griseb. HAC
- **Agrostis borealis* Hartm. LAC
- Calamagrostis neglecta* (Ehrh.) Gaertn., Mey. & Scherb. LAC
- C. inexpansa* Gray (s. lat.) HSA
- C. canadensis* (Michx.) Nutt. (s. lat.) HSC
- C. deschampsoides* Trin. HSC
- Beckmannia syzigachne* (Steud.) Fern. LSA
- Hierochloë odorata* (L.) Beauv. HSC
- **H. pauciflora* R. Br. LAC
- **Eleocharis acicularis* (L.) R. & S. HSC
- E. palustris* (L.) R. & S. LSC
- **E. smallii* Britt. LSEA
- E. pauciflora* (Lightf.) Link var. *fernaldii* Svenson LSEA
- **E. uniglumis* (Link) Schultes LSC
- Scirpus hudsonianus* (Michx.) Fern. LSC
- **S. rufus* (Huds.) Schrad. var. *neogaeus* Fern. LSA
- S. caespitosus* L. ssp. *austriacus* (Palla) Aschers. & Graebn.
- HSC,
- Eriophorum scheuchzeri* Hoppe HAC
- E. chamissonis* C. A. Meyer LSA
- E. russeolum* Fries var. *albidum* Nyl. LAC
- E. vaginatum* L. ssp. *spissum* (Fern.) Hult. LAA
- E. brachyantherum* Trautv. LAC
- E. callitrix* Cham. LAA
- (var. *moravium* Raymond also present)

- E. angustifolium* Honck. LAC
 **E. gracile* W. D. J. Koch LSC
 **Kobresia simpliciuscula* (Wahlenb.) Mack. HAC
 **K. myosuroides* (Vill.) Fiori & Paol. HAC
Carex capitata L. HSC
 **C. arctogena* H. Smith HSX
 **C. ursina* Dewey LAC
C. gynocrates Wormsk. HSC
C. maritima Gunn. HAC
 **C. dutillyi* O'Neill & Duman LSA
 (Churchill endemic closely related to *C. maritima* Gunn.)
 **C. chordorrhiza* Ehrh. HSC
C. diandra Schrank LSC
 **C. disperma* Dewey LSC
C. bipartita Bellardi var. *amphigena* (Fern.) Polunin HAC
C. amblyorhyncha Krecz. LAC
C. mackenziei Krecz. LSC
C. canescens L. HSC
C. leptalea Wahlenb. LSA
 **C. rupestris* All. HAC
C. scirpoidea Michx. LAX
 **C. supina* Wahlenb. ssp. *spaniocarpa* (Steud.) Hult. LAA
 **C. deflexa* Hornem. HSA
C. concinna R. Br. LSA
C. glacialis Mack. LAC
C. bicolor All. LAC
C. aurea Nutt. LSA
 **C. garberi* Fern. var. *bifaria* Fern. LSA
 **C. subspathacea* Wormsk. LAC
C. aquatilis Wahlenb. HSC
C. stans Drej. HAC
 **C. bigelowii* Torr. HAC
C. norvegica Retz. (s. lat.) LAX
C. media R. Br. LSA
C. adelostoma Krecz. HSA
C. atrofusca Schk. HAC
C. rariflora (Wahlenb.) Sm. LAC
C. limosa L. HSC
C. capillaris L. LAC
 (var. *major* Drej. and var. *elongata* Olney also present)
C. williamsii Britt. HSA
 **C. livida* (Wahlenb.) Willd. var. *grayana* (Dew.) Fern. LSA
C. vaginata Tausch LAC

- C. microglochin* Wahlenb. LAC
 **C. rostrata* Stokes LSC
C. oligosperma Michx. (repr. by var. *churchilliana* Raymond) LSA
C. saxatilis L. var. *rhomalea* Fern. LAA
C. rotundata Wahlenb. HSWA
C. membranacea Hook. HAA
 **Lemna minor* L. LSC
L. trisulca L. LSC
 **Juncus bufonius* L. (repr. by var. *halophilus* Buch. & Fern.) LSC
J. arcticus Willd. LAC
J. balticus Willd. var. *littoralis* Engelm. LSA
J. albescens (Lange) Fern. HAA
J. alpinus Vill. var. *rariflorus* Hartm. LSC
J. castaneus Sm. LAC
 (var. *pallidus* Hook. also present)
Luzula parviflora (Ehrh.) Desv. HSC
L. multiflora (Retz.) Lejeune ssp. *frigida* (Buch.) Krecz. HSC
L. confusa Lindeberg HAC
 **L. groenlandica* Böcher HSA
Tofieldia pusilla (Michx.) Pers. LAC
Smilacina trifolia (L.) Desf. LSA
Cypripedium passerinum Richards. LSA
Orchis rotundifolia Banks HSA
Habenaria hyperborea (L.) R. Br. HSA
H. obtusata (Pursh) Richards. HSA
Spiranthes romanzoffiana Cham. LSX
Listera borealis Morong LSA
 **L. cordata* (L.) R. Br. HSC
Corallorhiza trifida Chat. HSC
Populus balsamifera L. HSA
Salix reticulata L. LAC
S. vestita Pursh HSA
S. arctophila Cockerell HAA
S. glauca L. var. *acutifolia* (Hook.) Schneid. HSWA
S. cordifolia Pursh var. *callicarpaea* (Trautv.) Fern. LAX
 (var. *tonsa* Fern. also present)
S. brachycarpa Nutt. var. *antimima* (Schneid.) Raup HSA
 (var. *mexiae* Ball also present)
S. myrtillifolia Anderss. HSA
S. calcicola Fern. LAEA
S. alaxensis (Anderss.) Cov. LAWA
S. candida Flügge LSA
S. bebbiana Sarg. LSA
S. pedicellaris Pursh var. *hypoglauca* Fern. LSA
S. planifolia Pursh HSA

- S. arbusculoides* Anderss. LSWA
Myrica gale L. HSC
Betula glandulosa Michx. HSA
 (var. *glandulifera* (Regel) Gl. also present)
 **B. minor* (Tuckerm.) Fern. LSEA
 **Alnus crispa* (Ait.) Pursh (repr. by var. *mollis* Fern.) HSA
Geocaulon lividum (Richards.) Fern. LSA
 **Koenigia islandica* L. LAC
Rumex occidentalis Wats. LSA
 **R. triangulivalvis* (Danser) Rech. f. LSA
 **R. maritimus* L. var. *fueginus* (Philippi) Dusen LSA
Polygonum viviparum L. HAC
 **P. boreale* (Lange) Small LSX
 **P. amphibium* L. var. *stipulaceum* (Coleman) Fern. LSA
 **Salicornia europaea* L. LSC
 **Suaeda ?maritima* (L.) Dumort. HSC
Atriplex patula L. var. *hastata* (L.) Gray LSC
 **A. glabriuscula* Edmonston LSX
 **Montia lamprosperma* Cham. LAC
Melandrium apetalum (L.) Fenzl HAC
M. affine (J. Vahl) Hartm. (incl. *M. gillettii* (Boivin) Ritchie) HAC
Stellaria longipes Goldie HSC
S. monantha Hult. HAA
S. ciliatosepala Trautv. HAC
S. calycantha (Ledeb.) Bongard HSC
S. longifolia Muhl. LSC
S. crassifolia Ehrh. LAC
S. humifusa Rottb. HAC
Arenaria rubella (Wahlenb.) Sm. HAC
 **A. rossii* R. Br. HAX
 **A. uliginosa* Schleich. LAC
 **A. dawsonensis* Britt. LSA
 **A. humifusa* Wahlenb. LAX
A. lateriflora L. LSC
A. peploides L. var. *diffusa* Hornem. LAC
Cerastium alpinum L. (s. lat.) HAX
 **Sagina nodosa* (L.) Fenzl HSX
 **Spergularia marina* (L.) Griseb. LSC
Caltha palustris L. LSC
Ranunculus aquatilis L. var. *capillaceus* (Thuill.) DC. HSC
 (var. *eradicatus* Laestad. also present)
R. circinatus Sibth. var. *subrigidus* (Drew) Benson HSA
R. gmelini DC. var. *hookeri* (D. Don) Benson HSA
R. sceleratus L. (incl. var. *multifidus* Nutt.) LSC
 **R. hyperboreus* Rottb. HAC
R. pedatifidus Sm. var. *leiocarpus* (Trautv.) Fern. HAC

- **R. pallasii* Schlecht. HSC
- R. lapponicus* L. LAC
- R. cymbalaria* Pursh (incl. var. *alpinus* Hook.) HSA
- Anemone parviflora* Michx. HSA
- A. richardsonii* Hook. HSA
- A. multifida* Poir. LSA
- (var. *richardsiana* Fern. also present)
- Draba alpina* L. HAC
- D. lactea* Adams HAC
- D. nivalis* Liljebl. HAC
- D. cinerea* Adams HAC
- D. glabella* Pursh LAC
- D. lanceolata* Royle HSC
- **D. luteola* Greene HSA
- D. incana* L. (repr. by var. *confusa* (Ehrh.) Liljebl.) HSX
- D. nemorosa* L. var. *lejocarpa* Lindbl. LSC
- **Eutrema edwardsii* R. Br. HAC
- Cochlearia officinalis* L. (repr. by ssp. *groenlandica* (L.) Porsild) HAC
- Lesquerella arctica* (Wormsk.) Wats. HAC
- **Braya novae-angliae* Th. Sør. var. *interior* Böcher HSWA
- **Hutchinsia procumbens* (L.) Desv. LSC
- Rorippa islandica* (Oeder) Borbas var. *fernaldiana* Butt. & Abbe HSA
- Barbarea orthoceras* Ledeb. HSA
- **Descurainia sophioides* (Fisch.) O. E. Schulz HSWA
- Cardamine pratensis* L. var. *palustris* Wimm. & Grab. HAA
- (var. *angustifolia* Hook. also present)
- **Arabis alpina* L. LAX
- A. divaricarpa* Nels. LSA
- A. arenicola* (Richards.) Gel. var. *pubescens* (Wats.) Gel. HAA
- Saxifraga oppositifolia* L. HAC
- S. hirculus* L. HAC
- S. rivularis* L. HAC
- S. aizoides* L. HAX
- S. tricuspidata* Rottb. HAA
- S. caespitosa* L. ssp. *eucaespitosa* Engl. & Irmsch. LAX
- (ssp. *exaratoidea* (Simm.) Engl. & Irmsch. also present)
- **Mitella nuda* L. LSA
- Chrysosplenium tetrandrum* (Lund) Fries LAC
- Parnassia kotzebuei* Cham. HSA
- P. multiseta* (Ledeb.) Fern. HSC
- Ribes hudsonianum* Richards. HSA
- R. triste* Pallas HSA
- R. lacustre* (Pers.) Poir. LSA
- R. oxyacanthoides* L. LSA

- Fragaria virginiana* Duchesne var. *terrae-novae* (Rydb.)
Fern. & Wieg. LSA
- **Rosa acicularis* Lindl. var. *bourgeauiana* Crepin LSA
- **Geum aleppicum* Jacq. var. *strictum* (Ait.) Fern. LSA
G. macrophyllum Willd. var. *perincisum* (Rydb.) Raup LSA
- Dryas integrifolia* M. Vahl HAA
- **Potentilla fruticosa* L. HSC
P. palustris (L.) Scop. var. *parvifolia* (Raf.) Fern. & Long HSC
P. pulchella Pursh HAX
P. multifida L. LSC
- **P. pensylvanica* L. var. *pectinata* (Raf.) Lepage LSA
P. egedei Wormsk. var. *groenlandica* (Tratt.) Polunin HSA
P. nivea L. LAC
(ssp. *chamissonis* (Hult.) Hiitonen also present)
P. norvegica L. HSA
Rubus chamaemorus L. HSC
R. acaulis Michx. HSA
- **R. paracaulis* Bailey LSA
Astragalus eucosmus Robins. HSA
A. alpinus L. LAC
Oxytropis campestris (L.) DC. var. *varians* (Rydb.) Barneby HSWA
- **O. terra-novae* Fern. HSEA
Hedysarum mackenzii Richards. LAA
- **Lathyrus japonicus* Willd. var. *aleuticus* (Greene) Fern. HSC
Linum lewisii Pursh (repr. by f. *lepagei* (Boivin) Lepage) HSA
Callitriche hermaphroditica L. HSC
Empetrum nigrum L. (incl. var. *hermaphroditum* (Lge.) Sørensen) HAC
Viola palustris L. HSX
- **V. pallens* (Banks) Brainerd HSA
- **V. renifolia* Gray var. *brainerdii* (Greene) Fern. LSA
Shepherdia canadensis (L.) Nutt. LSA
Epilobium latifolium L. HAC
E. angustifolium L. var. *intermedium* (Wormsk.) Fern. HSA
E. davuricum Fisch. HSC
E. palustre L. HSC
E. glandulosum Lehm. var. *adenocaulon* (Haussk.) Fern. LSA
Myriophyllum spicatum L. ssp. *exalbescens* (Fern.) Hult. HSA
Hippuris vulgaris L. LAC
H. tetraphylla L. f. HSC
- **Cicuta bulbifera* L. LSA
C. mackenzieana Raup LSA
- **Heracleum lanatum* Michx. LSA
Moneses uniflora (L.) Gray HSC

- Pyrola minor* L. HSC
P. secunda L. (incl. var. *obtusata* Turcz.) HSC
P. grandiflora Rad. LAC
Ledum groenlandicum Oeder HSA
L. decumbens (Ait.) Lodd. LAA
Rhododendron lapponicum (L.) Wahlenb. LAC
Loiseleuria procumbens (L.) Desv. LAC
**Kalmia polifolia* Wang. HSA
Andromeda polifolia L. HSC
Arctostaphylos alpina (L.) Spreng. LAC
A. rubra (Rehd. & Wils.) Fern. HSA
A. uva-ursi (L.) Spreng. var. *coactilis* Fern. & Macbr. LSA
Oxycoccus microcarpus Turcz. HSC
Vaccinium uliginosum L. (incl. var. *alpinum* Bigel.) HAC
V. vitis-idaea L. var. *minus* Lodd. LAC
Primula stricta Hornem. LAX
P. egalikensis Wormsk. HSA
Androsace septentrionalis L. HAC
 (var. *robusta* St. John also present)
**Naumburgia thyrsiflora* (L.) Duby LSC
Gentianella propinqua (Richards.) J.M. Gillett HSA
**G. amarella* (L.) Börner ssp. *acuta* (Michx.) J.M. Gillett LSA
Lomatogonium rotatum (L.) Fries HSC
Menyanthes trifoliata L. HSC
Mertensia maritima (L.) F. J. Gray (repr. by var. *tenella* Fr.) LAC
**Mentha arvensis* L. var. *villosa* (Benth.) Stewart LSA
**Scutellaria galericulata* L. var. *epilobiifolia* (Hamilt.) Jordal LSA
Limosella aquatica L. HSC
Euphrasia arctica Lange LAX
Bartsia alpina L. LAX
Castilleja raupii Pennell HSA
Rhinanthus borealis (Sterneck) Chabert HSC
Pedicularis flammea L. LAX
P. labradorica Wirsing HSC
P. lapponica L. LAC
P. groenlandica Retz. HSA
P. sudetica Willd. HAC
Pinguicula vulgaris L. LAC
P. villosa L. HSC
Utricularia minor L. HSC
U. intermedia Hayne HSC
U. vulgaris L. HSC
Plantago maritima L. ssp. *juncooides* (Lam.) Hult. HSA
Galium brandegei Gray HSA
G. trifidum L. LSC
 (var. *halophilum* Fern. & Wieg. also present)

- Linnaea borealis* L. ssp. *americana* (Forbes) Hult. HSA
 **Valeriana dioica* L. ssp. *sylvatica* (Sol.) Mey. LSA
Campanula uniflora L. HAX
C. uliginosa Rydb. LSA
Solidago multiradiata Ait. HSA
Aster puniceus L. LSA
 **A. junciformis* Rydb. LSA
Erigeron elatus Greene HSA
 **E. lonchophyllus* Hook. LSA
E. angulosus Gaud. var. *kamtschaticus* (DC.) Hara HSC
E. humilis Graham LAC
 **Antennaria rosea* (D.C. Eat.) Greene LSA
 **A. pulcherrima* (Hook.) Greene HSA
Achillea borealis Bongard HSC
Matricaria ambigua (Ledeb.) Kryl. LAC
Chrysanthemum arcticum L. HSC
Petasites palmatus (Ait.) Gray HSA
P. sagittatus (Pursh) Gray HSA
 **Artemisia tilesii* Ledeb. var. *elatior* T. & G. LAWA
Arnica alpina (L.) Olin ssp. *attenuata* (Greene) Maguire HSA
Senecio pauperculus Michx. LSA
S. indecorus Greene LSA
S. congestus (R. Br.) DC. LAC
 (var. *palustris* (L.) Fern. and var. *tonsus* Fern. also present)
Taraxacum lacerum Greene LAA
 **T. croceum* Dahlst. (incl. *T. lapponicum* Kihlm.) LAX
 **T. ceratophorum* (Ledeb.) DC. HSC

Beckel, Law, and Irvine (1954) have outlined the major terrain types of the Churchill area, and Ritchie (1956) has given examples of the vegetation associated with the various terrains. The following amplified lists have been made up for the convenience of visitors to the area, often with a very limited time at their disposal, who wish to gain as complete a picture as possible under such circumstances of the vegetation of the various types of habitat.

SANDY FORESHORE ("STRAND")

Elymus arenarius ssp. *mollis*
Carex maritima
Arenaria peploides var. *diffusa*
Lathyrus japonicus var. *aleuticus*
Matricaria ambigua
Artemisia tilesii var. *elatior*

SALT MARSHES AND COASTAL FLATS

Triglochin maritima
Puccinellia langeana
P. vaginata
P. pumila
P. lucida
P. nuttalliana
P. phryganodes
Dupontia fisheri ssp. *psilosantha*
Hordeum jubatum (introd.)
Catabrosa aquatica
Calamagrostis deschampsiioides
Carex mackenziei
C. subspathacea
C. ursina
Scirpus rufus var. *neogaeus*
Eleocharis pauciflora var. *fernaldii*
Juncus balticus var. *littoralis*

J. bufonius var. *halophilus*
Koenigia islandica
Polygonum boreale
Rumex occidentalis
Suaeda ?*maritima*
Salicornia europaea
Atriplex patula var. *hastata*
A. glabriuscula
Montia lamprosperma
Stellaria humifusa
S. crassifolia
Spergularia marina
Ranunculus cymbalaria
Hutchinsia procumbens
Cochlearia officinalis ssp. *groenlandica*
Potentilla egedei var. *groenlandica*
Hippuris tetraphylla
Lomatogonium rotatum
Plantago maritima ssp. *juncoides*
Galium trifidum var. *halophilum*
Chrysanthemum arcticum
Matricaria ambigua
Aster puniceus
A. junciformis

SANDY UPPER BEACH

Elymus arenarius ssp. *mollis*
Festuca brachyphylla
Poa alpigena
Trisetum spicatum
Calamagrostis neglecta
C. deschampsoides
Hierochloë odorata
Carex scirpoidea
C. maritima
Juncus arcticus
J. balticus var. *littoralis*

Stellaria longipes
Arenaria peploides var. *diffusa*
A. humifusa
Arabis arenicola var. *pubescens*
Braya novae-angliae var. *interior*
Eutrema edwardsii
Descurainia sophioides
Lesquerella arctica
Potentilla multifida
P. pensylvanica var. *pectinata*
P. pulchella
Linum lewisii f. *lepagei*
Arctostaphylos rubra
Androsace septentrionalis
Gentianella propinqua
Castilleja raupii
Solidago multiradiata
Achillea borealis
Matricaria ambigua

STABLE DUNES ABOVE UPPER BEACH

Equisetum variegatum
E. arvense var. *boreale*
E. scirpoides
Triglochin maritima
Festuca brachyphylla
Poa alpina
Arctophila fulva
Trisetum spicatum
Calamagrostis inexpansa
C. canadensis var. *scabra*
Deschampsia caespitosa var. *littoralis*
Carex scirpoidea
C. concinna
C. deflexa
C. glacialis

C. aurea
C. vaginata
C. capillaris
C. norvegica
C. microglochin
Scirpus caespitosus ssp. *austriacus*
Juncus albescens
Luzula parviflora
L. groenlandica
Tofieldia pusilla
Habenaria hyperborea
Salix reticulata
S. vestita
S. arctophila
S. cordifolia var. *callicarpaea*
S. planifolia
S. candida
Betula glandulosa
Rumex occidentalis
Polygonum viviparum
Stellaria humifusa
Arenaria rossii
Anemone multifida
Draba glabella
D. incana
D. luteola
Arabis arenicola var. *pubescens*
Eutrema edwardsii
Barbarea orthoceras
Lesquerella arctica
Parnassia multiseta
Saxifraga aizoides
S. oppositifolia
Ribes oxycanthoides
Dryas integrifolia
Potentilla nivea
P. pensylvanica var. *pectinata*
Rosa acicularis var. *bourgeauiana*

Rubus acaulis
Astragalus eucosmus
A. alpinus
Oxytropis campestris var. *varians*
O. terrae-novae
Hedysarum mackenzii
Linum lewisii f. *lepagei*
Empetrum nigrum
Shepherdia canadensis
Epilobium latifolium
E. angustifolium var. *intermedium*
E. palustre
Pyrola grandiflora
Arctostaphylos rubra
Rhododendron lapponicum
Andromeda polifolia
Vaccinium uliginosum
Primula stricta
P. egaliksensis
Androsace septentrionalis
Gentianella propinqua
Euphrasia arctica
Rhinanthus borealis
Pedicularis flammea
Castilleja raupii
Erigeron humilis
E. elatus
Solidago multiradiata
Achillea borealis
Taraxacum lacerum

QUARTZITE RIDGE ABOVE STABLE DUNE AREA

Dryopteris disjuncta
Cystopteris fragilis
Botrychium lunaria
Juniperus communis var. *depressa*

Festuca brachyphylla
Poa alpina
P. glauca
P. alpigena
P. arctica
Alopecurus alpinus
Agrostis borealis
Trisetum spicatum
Carex concinna
C. rupestris
C. glacialis
C. media
Kobresia myosuroides
K. simpliciuscula
Juncus albescens
J. castaneus
Luzula confusa
L. multiflora ssp. *frigida*
Tofieldia pusilla
Habenaria obtusata
Cypripedium passerinum
Salix reticulata
S. glauca var. *acutifolia*
S. cordifolia var. *callicarpaea*
S. arctophila
S. planifolia
S. calcicola
S. alaxensis
Betula glandulosa
Polygonum viviparum
Arenaria rubella
Cerastium alpinum
Stellaria longipes
S. monantha
S. crassifolia
Melandrium affine
M. apetalum
Ranunculus pedatifidus var. *leiocarpus*

Anemone parviflora
A. richardsonii
Draba nivalis
D. lactea
D. cinerea
D. alpina
D. glabella
Saxifraga tricuspidata
S. oppositifolia
S. rivularis
S. aizoides
S. caespitosa ssp. *eucaespitosa*
Ribes hudsonianum
Dryas integrifolia
Potentilla nivea
P. norvegica
P. pulchella
P. pensylvanica var. *pectinata*
Geum macrophyllum var. *perincisum*
Astragalus alpinus
A. eucosmus
Oxytropis campestris var. *varians*
O. terrae-novae
Empetrum nigrum
Epilobium davuricum
E. latifolium
Pyrola grandiflora
P. secunda var. *obtusata*
Arctostaphylos alpina
A. rubra
Rhododendron lapponicum
Loiseleuria procumbens
Ledum decumbens
Bartsia alpina
Euphrasia arctica
Pedicularis flammea
P. labradorica

P. lapponica
Campanula uniflora
Arnica alpina ssp. *attenuata*
Antennaria rosea
Chrysanthemum arcticum

MARSHY GROUND, WET PEATY MEADOWS, AND MARGINS OF PONDS

Equisetum palustre
E. fluviatile
E. variegatum
Triglochin maritima
T. palustris
Festuca rubra
Poa palustris
Arctagrostis latifolia
Arctophila fulva
Glyceria striata var. *stricta*
Hierochloë pauciflora
Carex diandra
C. canescens
C. amblyorhyncha
C. gynocrates
C. mackenziei
C. scirpoidea
C. vaginata
C. capillaris
C. atrofusca
C. adelostoma
C. limosa
C. rariflora
C. livida var. *grayana*
C. garberi var. *bifaria*
C. oligosperma var. *churchilliana*
C. microglochin
C. aquatilis

C. stans
C. saxatilis var. *rhomalea*
C. rotundata
C. membranacea
C. rostrata
Eleocharis palustris
E. smallii
E. uniglumis
E. acicularis
Scirpus hudsonianus
S. caespitosus ssp. *austriacus*
Eriophorum brachyantherum
E. callitrix
E. chamissonis
E. scheuchzeri
E. russeolum var. *albidum*
E. vaginatum ssp. *spissum*
E. angustifolium
E. gracile
Juncus castaneus
J. alpinus var. *rariflorus*
Tofieldia pusilla
Habenaria hyperborea
H. obtusata
Spiranthes romanzoffiana
Salix candida
S. myrtillofolia
S. pedicellaris var. *hypoglauca*
Myrica gale
Betula glandulosa
Rumex triangulivalvis
R. occidentalis
R. maritimus var. *fueginus*
Arenaria uliginosa
Stellaria calycantha
S. ciliatosepala

Sagina nodosa
Caltha palustris
Ranunculus sceleratus
R. lapponicus
R. pallasii
R. hyperboreus
Rorippa islandica var. *microcarpa*
Cardamine pratensis var. *palustris*
Saxifraga hirculus
Chrysosplenium tetrandrum
Ribes lacustre
Potentilla palustris var. *parvifolia*
Viola pallens
V. palustris
Epilobium palustre
E. glandulosum var. *adenocaulon*
Hippuris vulgaris
Cicuta bulbifera
C. mackenzieana
Heracleum lanatum
Ledum groenlandicum
Naumburgia thyrsiflora
Lomatogonium rotatum
Menyanthes trifoliata
Mentha arvensis var. *villosa*
Scutellaria galericulata var. *epilobiifolia*
Pedicularis labradorica
P. sudetica
P. flammea
Pinguicula vulgaris
P. villosa
Galium trifidum
G. brandegei
Valeriana doica ssp. *sylvatica*
Campanula uliginosa
Petasites palmatus
P. sagittatus

Senecio congestus
Erigeron lonchophyllus
E. angulosus var. *kamtschaticus*
Antennaria pulcherrima
Senecio pauperculus
S. indecorus

OPEN WHITE SPRUCE STANDS

Equisetum scirpoides
Lycopodium complanatum
L. annotinum var. *pungens*
Polypodium virginianum
Picea glauca
Larix laricina
Juniperus communis var. *depressa*
Carex disperma
C. leptalea
C. deflexa
C. concinna
Smilacina trifolia
Tofieldia pusilla
Habenaria obtusata
Cypripedium passerinum
Orchis rotundifolia
Corallorhiza trifida
Listera cordata
Populus balsamifera
Salix bebbiana
S. myrtillofolia
S. arbusculoides
S. planifolia
S. reticulata
S. brachycarpa var. *antimima*
Betula glandulosa
Alnus crispa var. *mollis*
Geocaulon lividum
Polygonum viviparum

Mitella nuda
Parnassia kotzebuei
P. multiseta
Ribes triste
Rubus acaulis
R. paracaulis
R. chamaemorus
Fragaria virginiana var. *terrae-novae*
Empetrum nigrum
Viola renifolia var. *brainerdii*
Shepherdia canadensis
Pyrola minor
P. secunda var. *obtusata*
Moneses uniflora
Ledum groenlandicum
Arctostaphylos rubra
A. uva-ursi var. *coactilis*
Vaccinium uliginosum
V. vitis-idaea var. *minus*
Bartsia alpina
Pedicularis lapponica
P. labradorica
P. groenlandica
Linnaea borealis ssp. *americana*
Petasites sagittatus
Erigeron lonchophyllus

HUMMOCKY PEAT BOG

Picea mariana
Larix laricina
Carex vaginata
C. limosa
Tofieldia pusilla
Habenaria hyperborea
Rubus chamaemorus
Empetrum nigrum

Ledum decumbens
L. groenlandicum
Kalmia polifolia
Andromeda polifolia
Oxycoccus microcarpus
Vaccinium uliginosum
Pedicularis labradorica

SHALLOW PONDS

Sparganium angustifolium
S. hyperboreum
Potamogeton gramineus
P. friesii
P. alpinus var. *tenuifolius*
P. filiformis var. *borealis*
Lemna minor
L. trisulca
Polygonum amphibium var. *stipulaceum*
Ranunculus gmelini var. *hookeri*
R. aquatilis var. *capillaceus*
R. circinatus var. *subrigidus*
R. sceleratus
Callitriche hermaphrodita
Myriophyllum spicatum ssp. *exalbescens*
Hippuris vulgaris
H. tetraphylla
Limosella aquatica
Utricularia minor
U. intermedia
U. vulgaris

BIBLIOGRAPHY

- Alcock, P. J. (1916). The Churchill River. *Geog. Rev.* 2: 433-448.
- Antevs, E. (1931). Late-glacial correlations and ice recession in Manitoba. *Geol. Surv., Canada, Mem.* 168: 1-76.
- Bajkov, A. D. (1941). The ice conditions of Hudson Bay. *The Beaver*, March, 1941: 15-19.
- Beckel, Dorothy K. (1954). Growth of cultivated plants at Fort Churchill, Manitoba. Defence Research Board, Canada, Defence Research Northern Laboratory, Res. Note No. 12: 1-6.
- (1957). Studies on seasonal changes in the temperature gradient of the active layer of soil at Fort Churchill, Manitoba. *Arctic* 10: 151-183.
- Beckel, Dorothy K., C. E. Law, and B. R. Irvine (1954). Major terrain types of North American tundra and boreal forest areas with examples from the Churchill, Manitoba, area. Defence Research Board, Canada, Defence Research Northern Laboratory, Tech. Note No. 37.
- Beckett, Eva (1945). Plant life of the Churchill district. *Can. Geog. J.* 31: 96-104.
- (1951). Wild wings over the tundra. *Can. Geog. J.* 43: 170-177.
- Bell, R. (1880). Report on explorations on the Churchill and Nelson rivers and around God's and Island lakes. *Geol. Surv., Canada, Rept. Prog.* 1878-79 (pt. C): 1-72.
- (1898). Rising of the land around Hudson Bay. *Smith. Inst., Ann. Rept. for 1897*, pp. 359-367.
- Böcher, T. (1938). Biological distributional types in the flora of Greenland. *Meddel. om Grønland* 106: 1-339.
- Cheney, T. A., and Dorothy K. Beckel (1955). An environmental analysis of the Fort Churchill, Manitoba, region. Cornell University, Ithaca, N. Y., pp. 1-349.
- Cooke, H. C. (1942). Is the land around Hudson Bay at present rising? *Am. J. Sci.* 240: 144-146.
- Coombs, D. B. (1954). The physiographic subdivisions of the Hudson Bay Lowlands south of 60 degrees North. *Geog. Bull.* 6: 1-16.
- Department of Railways, Labour, and Industries, Saskatchewan (1933). The Hudson Bay route and the port of Churchill in the centre of Canada. Regina, Sask., pp. 1-63.
- Department of Transport, Canada (1939). Churchill and the Hudson Bay route. Ottawa, pp. 1-50.
- Elson, J. A. (1954). Pleistocene geology of southwestern Manitoba. *Geol. Surv., Canada, Guide Book (Field Excursion, Oct. 2-3. 1954)*.
- Fernald, M. L. (1950). *Gray's Manual of Botany*, 8th. ed. American Book Co., New York.
- Flint, R. F. (1952). The Ice Age in the North American Arctic. *Arctic* 5: 135-152.

- Flint, R. F. and E. S. Deevey (1951). Radiocarbon dating of late-Pleistocene events. *Am. J. Sci.* 249: 257-300.
- Gardner, G. (1937). Liste annotée des espèces de ptéridophytes, de phanérogames et d'algues récoltées sur la Côte du Labrador, à la Baie d'Hudson et dans le Manitoba Nord, en 1930 et 1933. *Bull. Soc. Bot. Fr.* 84: 1-33.
- Geographic Board of Canada (1933). Place-names of Manitoba. King's Printer, Ottawa.
- Giddings, J. L. (1941). Dendrochronology in northern Alaska. *Univ. of Arizona, Bull.* 12 (4).
- (1947). Mackenzie River Delta chronology. *Tree Ring Bull.* 13.
- Gillett, J. M. (1948). Botanical associations of the northern biting flies, Appendix E, report on the field work at Fort Churchill, Manitoba, 1948. Defence Research Board, Canada, Rept. No. D. R. 20: E1-E26.
- Gleason, H. A. (1952). The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. The New York Botanical Garden (3 vols.).
- Grøntved, J. (1936). Vascular plants from arctic North America. Fifth Thule Exped. Rept., 1921-24, 2: 1-93.
- Güßow, W. C. (1933). Contribution to the knowledge of the flora of northern Manitoba and the North-western Territories, Dominion of Canada. *Can. Field-Nat.* 47: 116-119.
- Gutenberg, B. (1942). Is the land around Hudson Bay at present rising? *Am. J. Sci.* 240: 147-149.
- Halliday, W. E. D. (1937). A forest classification for Canada. Dept. of Mines and Resources, Canada, Forest Service, Bull. 89: 1-50. (See also the revised map (1957) and revised text (1958).
- Hare, F. K. (1950). Climate and zonal divisions of the boreal forest formation in eastern Canada. *Geog. Rev.* 40: 615-635.
- (1951). Some climatological problems of the Arctic and sub-Arctic. In *Compendium of Meteorology*, Boston, Mass., pp. 952-964.
- Harrington, Lyn (1951). Manitoba Roundabout. The Ryerson Press, Toronto, Ontario.
- Hultén, E. (1958). The amphi-Atlantic plants and their phytogeographical connections. *Kungl. Svenska Vetensk. Handl.* 7: 1-340.
- Hustich, I. (1949). Phytogeographical regions of Labrador. *Arctic* 2: 36-42.
- (1953). The boreal limits of conifers. *Arctic* 6: 149-162.
- Innis, H. A. (1930). The fur trade in Canada. Yale University Press, New Haven, Conn., pp. 1-444.
- Jenness, J. L. (1949). Permafrost in Canada. *Arctic* 2: 13-27.
- Johansen, F. (1933). Description of the country and vegetation at Port Churchill, Man., in arctic Canada. *Nyt. Mag. Naturvid.* 73: 221-257.
- Johnston, W. A. (1930). Frozen ground in the glaciated parts of northern Canada. *Roy. Soc. Canada, Trans., Sect. IV*, pp. 31-40.

- (1939). Recent changes of level of the land relative to sea level. *Am. J. Sci.* 237: 94-98.
- (1946). Glacial Lake Agassiz, with special reference to the mode of deformation of the beaches. *Geol. Surv., Canada, Bull.* 7: 1-20.
- Leverett, F. (1932). Quaternary geology of Minnesota and parts of adjacent states. *U. S. Geol. Surv., Prof. Paper* 161: 1-149.
- Lougee, R. J. (1953). A chronology of postglacial time in eastern North America. *Sci. Monthly* 76: 259-276.
- Lowe, C. W. (1943). List of the flowering plants, ferns, club mosses and liverworts of Manitoba. *Nat. Hist. Soc. of Manitoba.*
- Macoun, J. M. (1911). Flora and fauna of the west coast of Hudson Bay. *Geol. Surv., Canada, Summ. Rept.* 1909-10: 281-283.
- Marr, J. W. (1948). Ecology of the forest-tundra ecotone on the east coast of Hudson Bay. *Ecol. Monogr.* 18: 118-144.
- McClure, H. E. (1943). Aspection in the biotic communities of the Churchill area, Manitoba. *Ecol. Monogr.* 13: 1-35.
- Moir, D. R. (1954). Beach ridges and vegetation in the Hudson Bay region. *Proc. N. Dak. Acad. Sci.* 8: 45-48.
- Montgomery, Margaret (1951). Does the Bay freeze? *The Beaver*, June, 1951: 12-15.
- Morton, A. S. (n. d.). A history of the Canadian West. Thomas Nelson and Sons, Toronto and New York, pp. 1-987.
- Palliser, John (1863). Exploration in British North America during the years 1857, 1858, 1859, and 1860. Eyre and Spottiswoode, London.
- Pinkerton, R. E. (1932). Hudson's Bay Company. Thornton Butterworth, London, pp. 1-320.
- Polunin N. (1951). The real Arctic; suggestions for its delimitation, subdivision and characterization. *J. Ecol.* 39: 308-315.
- Porsild, A. E. (1955). The vascular plants of the western Canadian Arctic Archipelago. *Nat. Mus. Canada, Bull.* 135: 1-226.
- (1957). Illustrated flora of the Canadian Arctic Archipelago. *Nat. Mus. Canada, Bull.* 146: 1-209.
- Potter, D. (1932). Botanical evidence of a post-Pleistocene marine connection between Hudson Bay and the St. Lawrence basin. *Rhod.* 34: 69-89.
- Preble, E. A. (1902). A biological investigation of the Hudson Bay region. *N. Am. Fauna*, No. 22: 1-140.
- Radforth, N. W. (1950). Progress report on organic terrain studies. National Research Council of Canada, Tech. Mem. No. 16.
- (1952). A suggested classification of muskeg for the engineer. National Research Council of Canada, Tech. Mem. No. 24.
- Rae, John (1850). Narrative of an expedition to the shores of the Arctic Sea. T. and W. Boone, London.
- Rae, R. W. (1951). Climate of the Canadian Arctic Archipelago. Can. Dept. of Transport, Ottawa.
- Raup, H. (1943). The willows of the Hudson Bay region and the Labrador Peninsula. *Sargentia* 4: 83-127.

- (1947). The botany of southwestern Mackenzie. *Sargentia* 6: 1-275.
- (1959). The willows of boreal western America. *Contr. Gray Herb.* No. 185: 3-95.
- Ritchie, J. C. (1956). The native plants of Churchill, Manitoba. *Can. J. Bot.* 34: 269-320.
- (1957). The vegetation of northern Manitoba. II. A prisere on the Hudson Bay Lowlands. *Ecology* 38: 429-435.
- Sanderson, Marie (1948). The climates of Canada according to the new Thornthwaite classification. *Sci. Agric.* 28: 501-517.
- Scoggan, H. J. (1951). Botanical investigations along the Hayes River route, northern Manitoba. *Nat. Mus. Canada, Bull.* 123: 139-161.
- (1957). Flora of Manitoba. *Nat. Mus. Canada, Bull.* 140: 1-619.
- Shelford, V. E., and A. C. Twomey (1941). Tundra animal communities in the vicinity of Churchill. *Ecology* 22: 47-69.
- Størmer, P. (1933). Plants collected by Frits Johansen in 1929, at Hudson Bay Railway and Port Churchill in arctic Canada. *Nyt. Mag. Naturvid.* 73: 259-272.
- Taverner, P. A., and G. M. Sutton (1934). The birds of Churchill, Manitoba. *Annals of the Carnegie Museum* 23: 1-83.
- Thomas, M. K. (1935). Climatological atlas of Canada. Division of Building Research, National Research Council, Canada, and Meteorological Division, Department of Transport, Canada, 253 pages.
- Thomson, J. W. (1953). Lichens of arctic America. I. Lichens from west of Hudson Bay. *The Bryologist* 56: 8-36.
- Thornthwaite, C. W. (1948). An approach toward a rational classification of climate. *Geog. Rev.* 38: 55-94.
- Trémaudan, A. H. de (1915). The Hudson Bay Road. J. M. Dent and Sons, London and Toronto, pp. 1-264.
- Tyrrell, J. B. (1896). Is the land around Hudson Bay at present rising? *Am. J. Sci.* 2: 200-205.
- (1897). Report on the Doobaunt, Kazan and Ferguson rivers and the north-west coast of Hudson Bay and on two overland routes from Hudson Bay to Lake Winnipeg. *Geol. Surv., Canada, Ann. Rept., Vol. 9, Pt. F:* 5-218.
- (1913). Hudson Bay exploring expedition. Bureau of Mines, Ontario, 22nd Rept.: 161-209.
- Upham, W. (1890). Report of exploration of the Glacial Lake Agassiz in Manitoba. *Geol. Surv., Canada, Ann. Rept., 1888-89, Pt. E.*
- (1895). The Glacial Lake Agassiz. *U. S. Geol. Surv., Monogr.* 25: 1-658.
- Williams, M. Y. (1948). The geological history of Churchill, Manitoba. *Western Miner* 21: 39-42.
- (1949). Churchill, Manitoba. *Can. Geog. J.* 39: 122-123.
- (1950). Churchill, Manitoba, a naturalists' rendezvous. *Can. Geog. J.* 40: 70-79.

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